System Motor Driver ICs for CD / DVD / Blu-ray Drive and Recorder

System Motor Driver IC for Half Height Drive (Sensor less)

BD7755RFV

No.10012EAT01

●Description

BD7755RFV are ICs, developed for the spindle motor, actuator coil, tilt coil, stepping motor, SA stepping motor and the loading motor drive of the desktop Blu-ray drive and Blu-ray recorder. Spindle driver adopted sensorless drive system, and the hall sensor (3 pieces) of the motor position detection is not needed, it is suitable for making of flexible cable conserve wiring and the reductions of external parts. The low rotation mode is built in, and stability and low-speed a rotation is achieved. The spindle, stepping and SA stepping use power MOSFET to reduce power consumption and the actuator, tilt, and loading driver use a linear BTL drive system to reduce noise.

●Features

1) The low-speed stability rotation is achieved with built-in the low rotation mode.
2) The hall sensor is unnecessary according to 3 aspect sensorless drive system.
3) The spindle motor driver achieves stability high speed start by ROHM's own energizing method.
4) Highly effective spindle, stepping and SA stepping is achieved by PWM control driver. And the output current detection resistance of stepping and SA stepping is unnecessary by built-in internal detection circuit.
5) The actuator, tilt and loading driver achieve low noise by using linear BTL drive system.
6) ON/OFF of loading and other channels, brake mode of spindle driver and standby mode are selectable by the two control terminals.
7) Built-in thermal-shut down circuit.
8) Improved heat radiation efficiency utilizing HTSSOP package.

●Applications

For desktop Blu-ray drive

●Absolute maximum ratings

Parameter	Symbol	Ratings	Unit
POWER MOS power supply voltage 1	SPVM, SLVM	15 #1	V
POWER MOS power supply voltage 2	SAVM	7 #2	V
Preblock/BTL power block power supply voltage	Vcc, AVM, LDVM	15	V
PWM control block power supply voltage	DVcc	7	V
Power dissipation	Pd	1.5 #3	W
Operating temperature range	Topr	-20 ~ 70	℃
Storage temperature	Tstg	-55 ~ 150	℃
Junction temperature	Tjmax	150	℃

#1 POWER MOS output terminals (40~43pin, 46～48pin) are contained.
#2 POWER MOS output terminals (35~38pin) are contained.
#3 PCB mounting (70mmX70mmX1.6mm, occupied copper foil is less than 3%, glass epoxy standard board).
Reduce by 12mW/℃ over 25℃

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●Recommended operating conditions

(Set the power supply voltage with consideration to power dissipation)

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Spindle / Sled motor driver power block power supply voltage	SPVM,SLVM	—	Vcc #4	—	V
Pre block power supply voltage	Vcc	10.8	12	13.2	V
Loading driver power block supply voltage	LDVM	4.3	5.0	Vcc	V
SA, Actuator driver power block power supply voltage	SAVM,AVM	4.3	5.0	5.5	V
PWM control block power supply voltage	DVcc	4.3	5.0	5.5	V
Spindle driver output current	Iosp	—	1.0	2.5 #5	A
Actuator, SA, sled, loading motor driver output current	Ioo	—	0.5	0.8	A

#4 Set the same supply voltage to SPVM, SLVM and Vcc.

#5 The current is guaranteed 3.5A in case of the Short-circuit braking mode and the current which is turned on/off in a duty-ratio of less than 1/10 with a maximum on-time of 5msec

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●Electrical characteristics

(Unless otherwise noted, Ta=25℃, Vcc=SPVM=SLVM=12V, DVcc=AVM=SAVM= LDVM=5V, Vc=1.65V,RL=8Ω,RLSP=2Ω)

Parameter	Symbol	Limits			Unit	Conditions
		MIN.	TYP.	MAX.		
Circuit current						
Quiescent current 1	IQ1	—	14	30	mA	Vcc(Loading OFF)
Quiescent current 2	IQ2	—	7.5	16	mA	Vcc(Loading ON)
Quiescent current 3	IQ3	—	7	14	mA	DVcc
Standby-on current 1	IST1	—	1.1	2.4	mA	Vcc
Standby-on current 2	IST2	—	0.16	0.4	mA	DVcc
Sled driver block						
Input dead zone (one side)	VDZSL	0	30	80	mV	
Input output gain	gmSL	0.75	1.0	1.25	A/V	
Output On resistor (top and bottom)	RONSL	—	2.2	3.8	Ω	IL=500mA
Output limit current	ILIMSL	0.8	1.1	1.4	A	
PWM frequency	fosc	—	100	—	kHz	
Spindle driver block<Torque instruction input / output>						
Input dead zone (one side)1	VDZSP1	20	55	90	mV	VLRPM=L
Input dead zone (one side)2	VDZSP2	20	240	450	mV	VLRPM=H
Input output gain 'H'	gmSPH	2.68	3.5	4.32	A/V	VLRPM=L
Input output gain 'L'	gmSPL	0.53	0.7	0.87	A/V	VLRPM=H
Output On resistor (top and bottom)	RONSP	—	1.0	1.7	Ω	IL=500mA
Output limit current	ILIMSP	1.35	1.6	1.85	A	RSPLIM=1.5kΩ
PWM frequency	fosc	—	167	—	kHz	
FG output, PRTFLG output						
High voltage	VOH	—	4.9	—	V	100kΩ pull up to DVcc
Low voltage	VOL	—	0.1	—	V	
Focus / Tracking / Tilt driver block						
Output offset voltage	VOFA	-50	0	50	mV	
Output saturation voltage (top and bottom)	VOHA	—	0.9	1.8	V	IL=500mA
Voltage gain H	GVAH	19.6	21.6	23.6	dB	VLRPM=L
Voltage gain L	GVAL	13.6	15.6	17.6	dB	VLRPM=H
SA stepping driver block						
Input dead zone (one side)	VDZSA	40	80	160	mV	
Input output gain	gmSA	0.15	0.2	0.25	A/V	
Output On resistor (top and bottom)	RONSA	—	1.3	2.5	Ω	IL=200mA
Output limit current	ILIMSA	0.28	0.4	0.52	A	
PWM frequency	fosc	—	100	—	kHz	
Loading driver block						
Output offset voltage	VOFLD	-50	0	50	mV	
Output saturation voltage (top and bottom) 1	VOLD1	—	0.7	1.6	V	IL=500mA LDVM=5V
Output saturation voltage (top and bottom) 2	VOLD2	—	2.1	3.6	V	IL=500mA LDVM=12V
Voltage gain	GVLD	15.5	17.5	19.5	dB	
CTL1,CTL2, LRPM						
Input high voltage	VIH	2.5	—	3.7	V	
Input low voltage	VIL	GND	—	0.5	V	
Others						
VC drop-muting	VMVC	0.4	0.7	1.0	V	
Vcc drop-muting	VMVcc	3.45	3.85	4.25	V	

*This product is not designed to be radiation-resistant.

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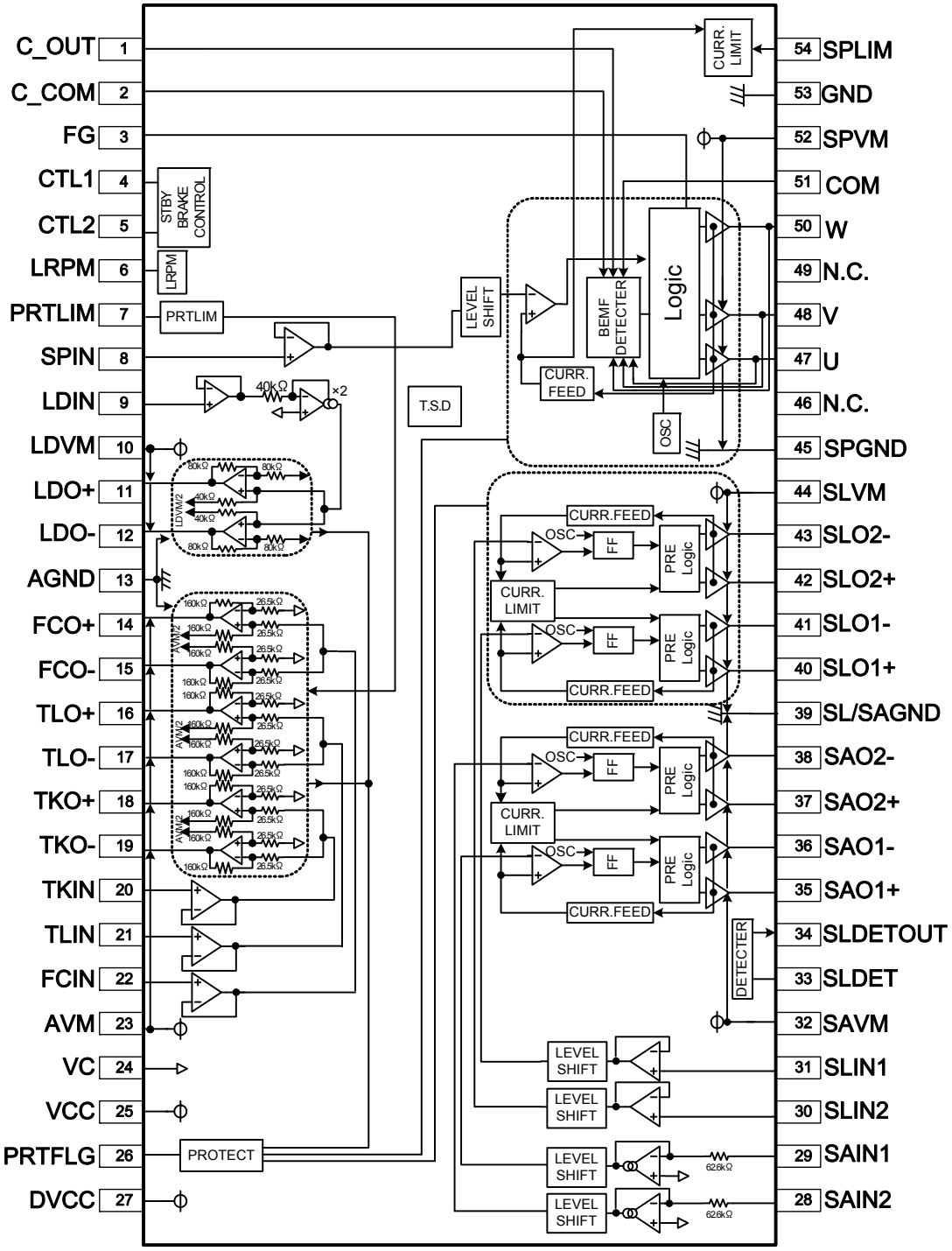
●Block diagram



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●Pin description

No.	Symbol	Description
1	C_OUT	Smooth capacitor connection terminal (output side)
2	C_COM	Smooth capacitor connection terminal (com side)
3	FG	Frequency generator output
4	CTL1	Driver logic control 1 input
5	CTL2	Driver logic control 2 input
6	LRPM	Low rotation mode change terminal
7	PRTLIM	Adjustable resistor connection for actuator protection
8	SPIN	Spindle driver input
9	LDIN	Loading driver input
10	LDVM	Loading driver block power supply
11	LDO+	Loading driver positive output
12	LDO-	Loading driver negative output
13	AGND	BTL driver block GND
14	FCO+	Focus driver positive output
15	FCO-	Focus driver negative output
16	TLO+	Tilt driver positive output
17	TLO-	Tilt driver negative output
18	TKO+	Tracking driver positive output
19	TKO-	Tracking driver negative output
20	TKIN	Tracking driver input
21	TLIN	Tilt driver input
22	FCIN	Focus driver input
23	AVM	Actuator driver block power supply
24	VC	Reference voltage input
25	Vcc	Pre block power supply
26	PRTFLG	Protection flag output
27	DVcc	PWM block control power supply

No.	Symbol	Description
28	SAIN2	SA driver 2 input
29	SAIN1	SA driver 1 input
30	SLIN2	Sled driver 2 input
31	SLIN1	Sled driver 1 input
32	SAVM	SA driver power block power supply
33	SLDET	Sled motor detection signal control input
34	SLDETOUT	Sled motor detection signal output
35	SAO1+	SA driver 1 positive output
36	SAO1-	SA driver 1 negative output
37	SAO2+	SA driver 2 positive output
38	SAO2-	SA driver 2 negative output
39	SL/SAGND	Sled/SA driver block pre and power ground
40	SLO1+	Sled driver 1 positive output
41	SLO1-	Sled driver 1 negative output
42	SLO2+	Sled driver 2 positive output
43	SLO2-	Sled driver 2 negative output
44	SLVM	Sled motor driver power supply
45	SPGND	Spindle driver power ground
46	N.C.	N.C.
47	U	Spindle driver output U
48	V	Spindle driver output V
49	N.C.	N.C.
50	W	Spindle driver output W
51	COM	Motor coil center point input
52	SPVM	Spindle driver power supply
53	GND	Pre block GND
54	SPLIM	Adjustable resistor connection for spindle driver current limit

*Positive/negative of the output terminals is determined in reference to those of the input terminals.

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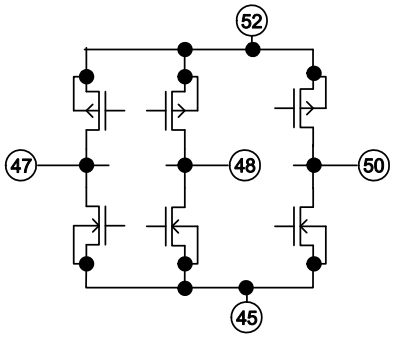
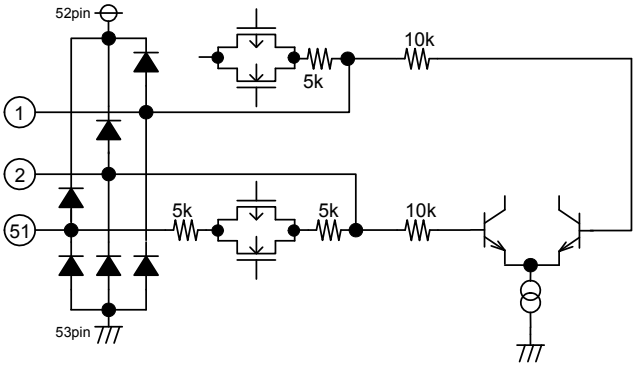
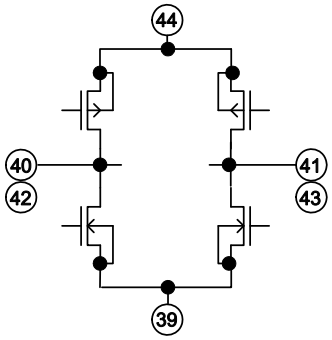
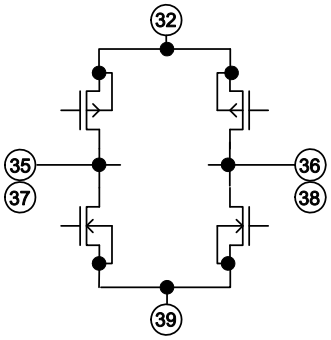
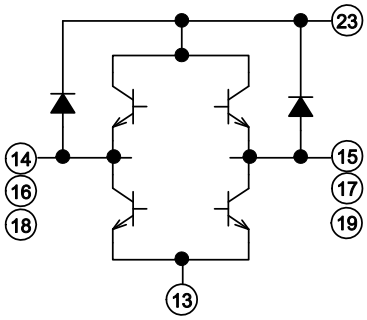
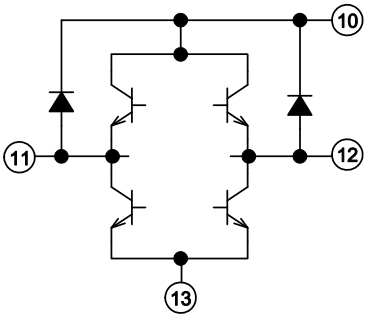
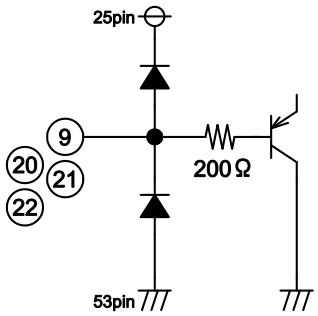
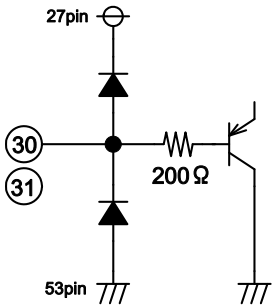
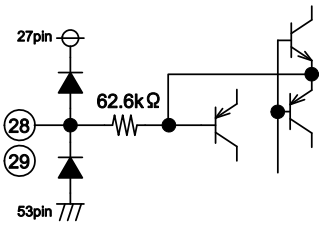
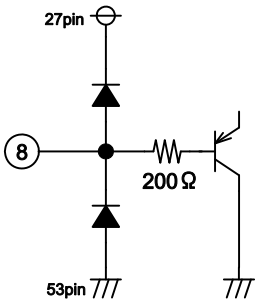
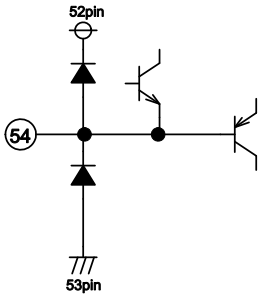
●Equivalent-circuit diagram of the terminals

Three-phase motor driver output	BEMF voltage detection input	
		
PWM driver output SLED1,2	PWM driver output SA1,2	BTL driver output FC,TK,TL
		
BTL driver output LD	BTL driver input FC,TK,TL,LD	PWM driver input SLED1,2
		
PWM driver input SA1,2	PWM driver input Spindle	Spindle current limit input
		

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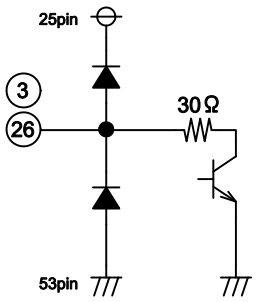
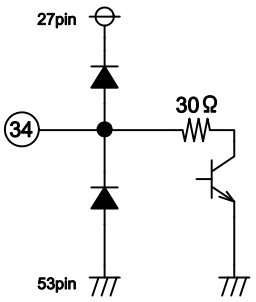
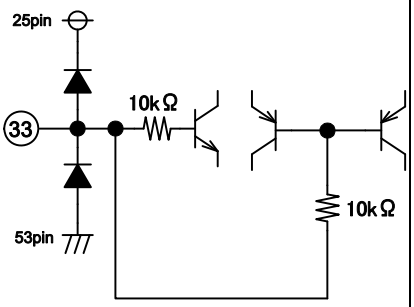
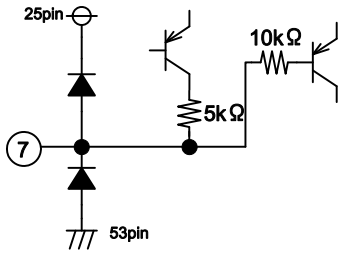
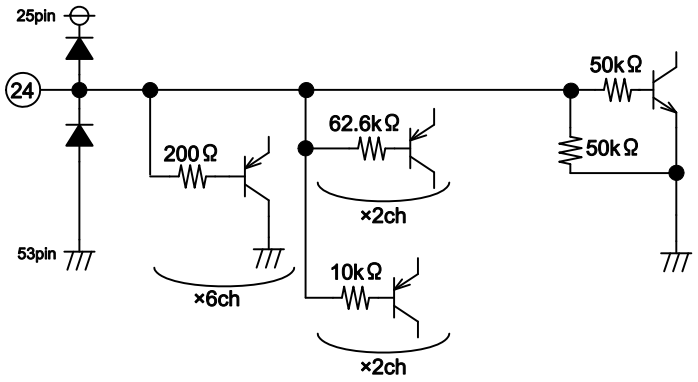
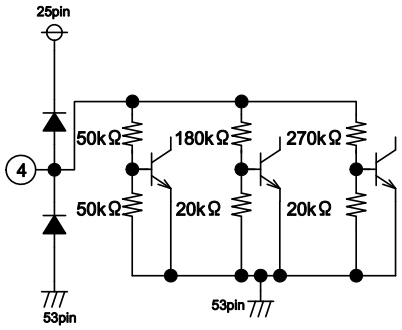
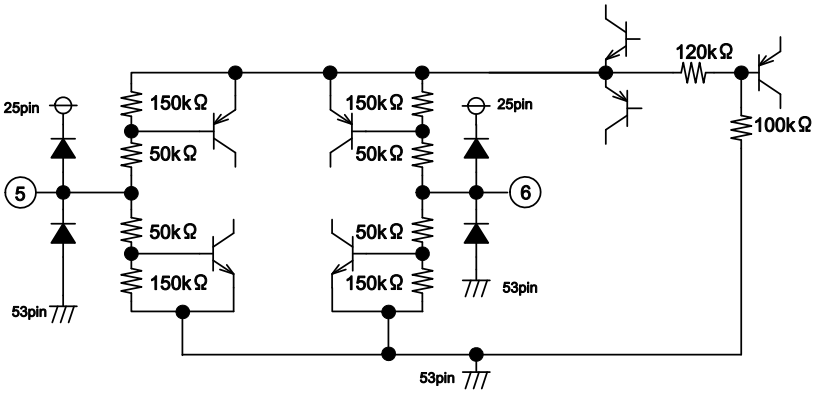
●Equivalent-circuit diagram of the terminals

PRTFLG, FG signal output	SLDETOUT signal output	SLED inner detection input
		
Actuator current limit input	**Control signal reference voltage input**	
		
Control signal input (CTL1)	**Control signal input (CTL2, LRPM)**	
		

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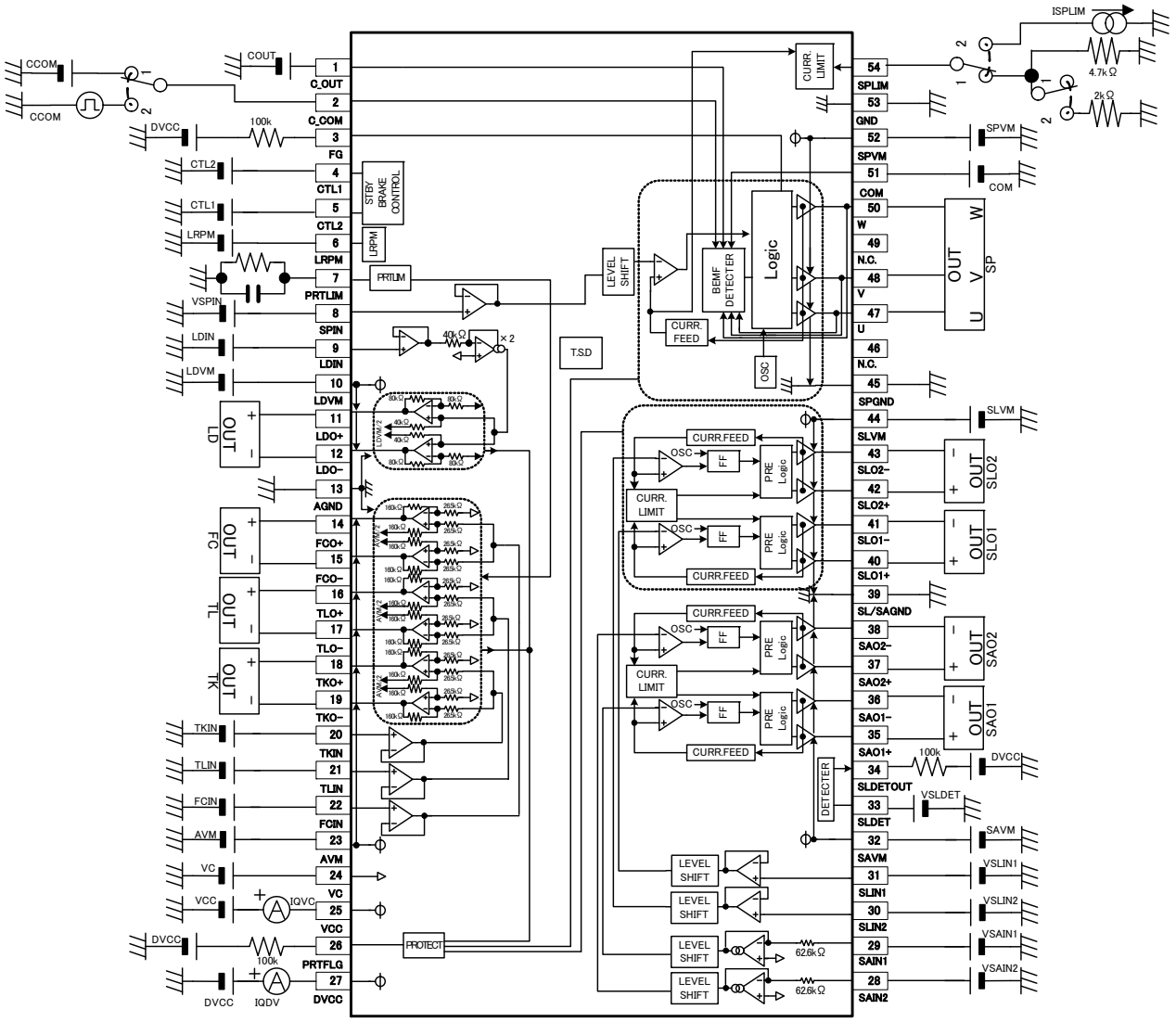
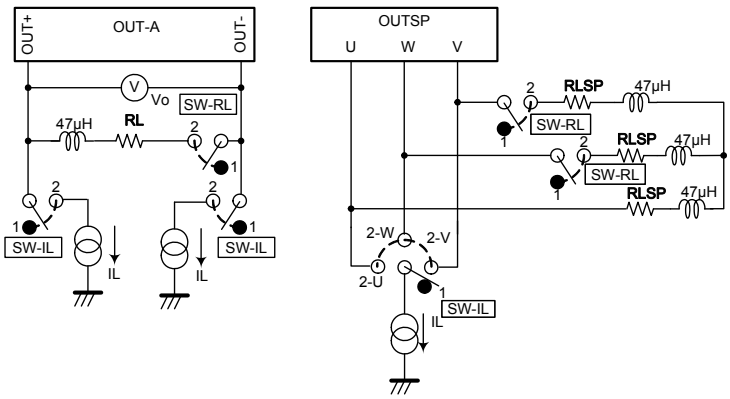
●Test circuit





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●Functional description

1-1. Driver logic control terminal 1and 2 (CTL1,2)

All drivers and spindle-drive braking modes can be switched on/off by inputting combinations of H-level signal (higher than 2.5V and lower than 3.7V), L-level signal (lower than 0.5V) and HiZ signal (open) to these terminals.

・Driver ON/OFF logic table

mode	CTL1	CTL2	SP	SL(2ch)	ACT(3ch)	SA(2ch)	LOADING
①	L, HiZ	L, HiZ	×	×	×	×	×
②	H	L	×	○	×	×	○
③	H	HiZ	○	○	○	×	×
④	L, HiZ	H	○	○	○	○	×
⑤	H	H	○	○	○	○	×

○:ON
×:OFF

① Stand-by mode
The IC is brought into stand-by mode, and its power dissipation can be limited.

② Drivers muting
All output channels, except the loading and sled motor are muted and their outputs are turned off.

③ SA mute mode
The loading and SA driver are muted.

④⑤ Loading OFF mode
Only the loading driver is muted.

・Spindle braking mode table

mode	CTL1	CTL2	SPIN > VC	SPIN < VC
③	H	HiZ	Forward-rotation mode	Reverse-rotation braking mode (LRPM=L)
④	L, HiZ	H		Short-circuit braking mode
⑤	H	H		Reverse-rotation braking mode (LRPM=L)

③⑤Reverse-rotation braking mode (spindle)
When SPIN < VC, all output are shorted to SPVM in 4500rpm (Typ.) or more, in less than 4500rpm (Typ.) the output become reverse-rotation braking mode.
Rotation speed is less than 140rpm when SPIN < VC, all the output are shorted to SPVM.
(However, the above-mentioned rotational speed is expressed in the case of 12pole motor.)

④ Short-circuit braking mode (spindle)
All the spindle driver outputs are shorted to SPVM when SPIN < VC.

1-2.Spindle output mode

The spindle output changes as follows by the setting of LRPM and SPIN. (CTL1=H,CTL2=H or HiZ)

Rotation speed		0rpm	400rpm	4500rpm
Normal mode	SPIN>VC	120° energizing	150° energizing	
LRPM=Low	SPIN<VC	120° energizing	150° energizing	Short brake
⑥ LRPM mode	SPIN>VC	120° energizing		
LRPM=High	SPIN<VC	(H,Hi-Z,Hi-Z)		

* PWM frequency becomes 30kHz (Typ.) in LRPM mode.
The torque at SPIN<VC becomes a counter torque

⑥ Low rotation mode
Please make to low rotation mode (LRPM=HI) after it starts in normal mode (LRPM=L).

1-3.Gain switching mode

Spindle driver and actuator driver can be switched on/off by inputting combinations of H-level signal (higher than 2.5V and lower than 3.7V), L-level signal (lower than 0.5V) and HiZ signal (open) to LRPM terminal.

LRPM	SP Gain	ACT Gain (3ch)
L	H gain (3.5A/V±0.82A/V)	H gain (21.6dB±2dB)
HiZ	L gain (0.7A/V±0.17A/V)	H gain (21.6dB±2dB)
H	L gain (0.7A/V±0.17A/V)	L gain (15.6dB±2dB)

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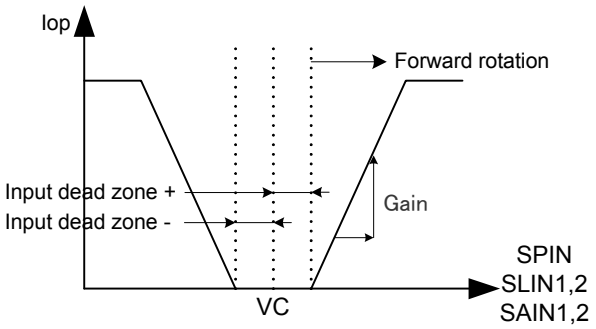
2. Output limit for spindle (SPLIM)

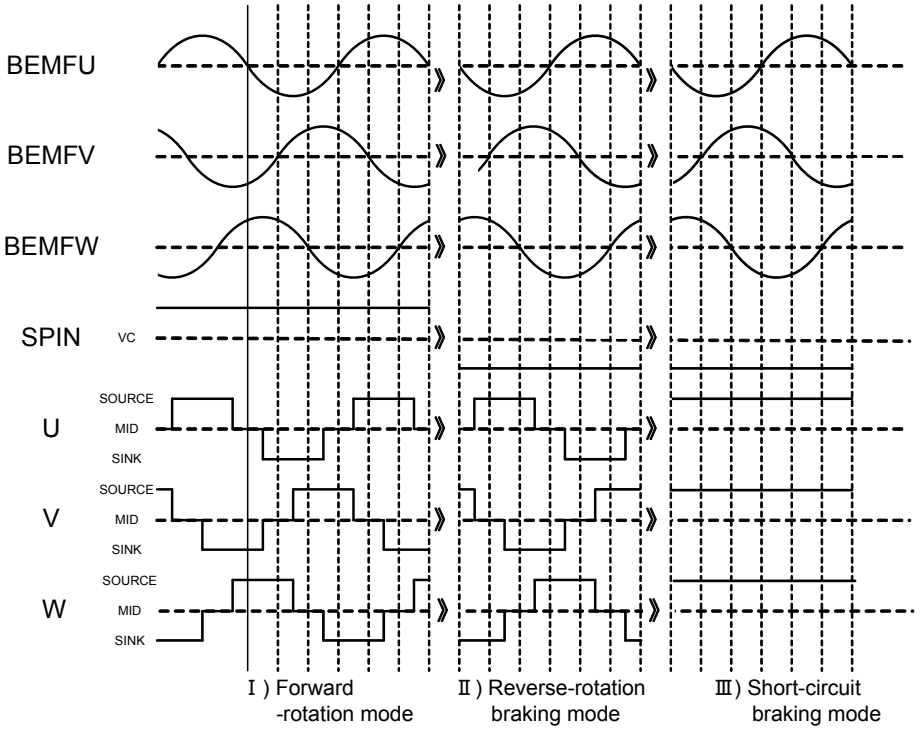
$$ILIMSP = \frac{A}{RSPLIM(\Omega)} (A) \quad A = 2420$$

3. Torque command (SPIN) (SLIN1,2) (SAIN1,2)
The relation between (the torque command inputs) and (Iosp or Ioo) is expressed in the figure below: The gain is defined by the inclination between two points. (Please exclude the dead zone from the input voltage when calculating Iop.)



4. FG output (FG)
3FG output begins after 900° degrees in electric angle, after the start mode ends and the BEMF detection starts. When the rotational speed becomes 24rpm (Max.) or less in case of brake, the FG output is fixed to high.
The above-mentioned rotation speed applies to the 12 pole motor.

5. Input/Output timing chart



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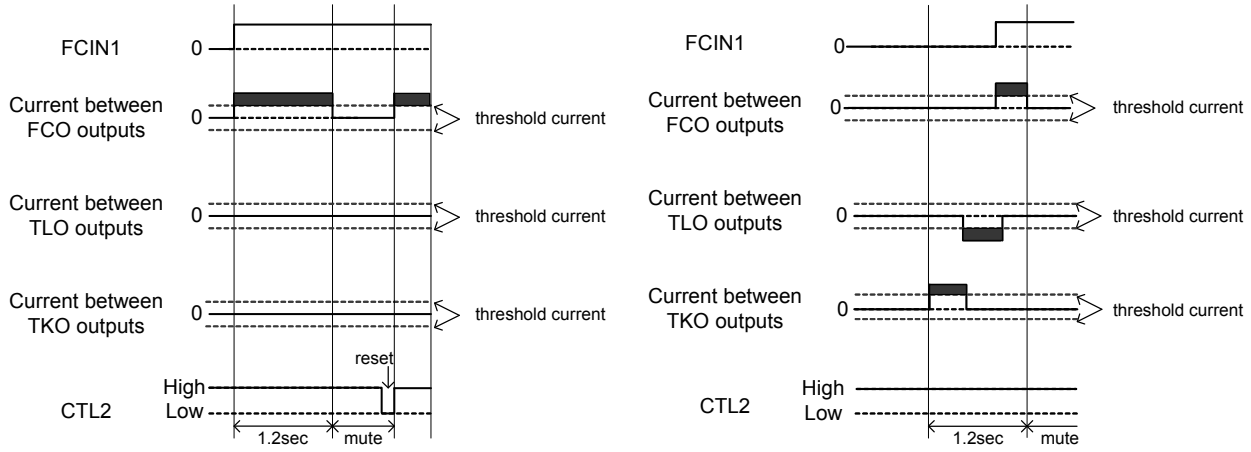
6. Protect system 1

It is a function to mute the actuator outputs when the IC outputs the current more than the setting threshold value IPRTLIM for 1.2sec because of the protection for the focus, the tracking, and the tilt coil. Outputs are muted similarly when the output current of two or three CHs continuously exceed the threshold for 1.2sec.
It returns to normal operation by setting CTL2=L.

$$IPRTLIM = \frac{A}{RPRTLIM(\Omega)}(A) \quad A = 8750$$

PRTFLG(OUTPUT)	Actuator output (FCO/TKO/TLO)
H	OFF
L	active

	MIN.	TYP.	MAX.	Unit
Time until protection function operates	1.0	1.2	1.4	s



7. Protect system 2

Function to protect against destruction of output terminal when output pin connects to GND or Vcc.

PRTFLG(OUTPUT)	Spindle, Sled motor driver output
H	OFF
L	active

- Spindle, Sled motor
- When SINK side POWER transistor has been turned on, if the output voltage (SPVM/2&SLVM/2<TYP> or more) are detected, the channel concerned will be turned off.
- When SOURCE side POWER transistor has been turned on, if the output voltage (SPVM/2&SLVM/2<TYP> or less) are detected, the channel concerned will be turned off.

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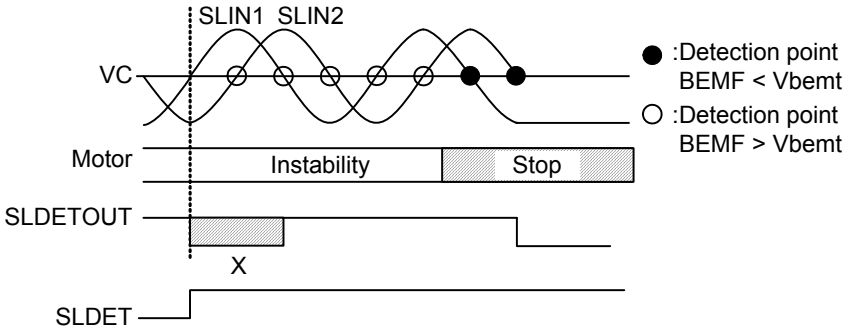
8. Inner detection function

BEMF of the motor is monitored according to timing for the sled input signal to pass VC, and Sled is detected reaching the inner. The judgment voltage of BEMF can be set according to the voltage input to the terminal SLDET. If BEMF below the judgment voltage is detected twice continuously, it becomes SLDETOUT=L. The inner detection function can be turned off with SLDET<0.5V. When the motor starts, the terminal SLDETOUT might become L because BEMF is unstable. Please take measures such as installing the time of the mask when it starts for the detection prevention.

Judgment voltage Vbemf =2.1 × (SLDET - VC) + 0.49



9. PWM oscillation frequency

The PWM oscillation for driving the spindle and sled is free running.
The sled and SA oscillating frequency is 100kHz (Typ.)
The spindle oscillating frequency is 167kHz (Typ.)

10. Muting functions

a) VC-drop muting
When the voltage at VC terminal drops to a value lower than 0.7V (Typ.), the outputs of all the channels are turned off. Set the VC terminal voltage higher than 1.0V.

b) Vcc-drop muting
When the voltage at DVcc terminal and Vcc terminal drop to lower than 3.85V (Typ.), the outputs of all the channels are turned off.

c) Over voltage protection circuit
When the voltage at SPVM terminal exceed 14.1V (Typ.), only the spindle block output is turned off.

11. Thermal-shut down

Thermal-shutdown circuit (over-temperature protection circuit) is built in to prevent the IC from thermal breakdown. Use the IC according to the thermal loss allowed in the package. In case the IC is left running over the allowed loss, the junction temperature rises, and the thermal-shutdown circuit works at a junction temperature of 175℃(Typ.) (All other channel outputs are turned off)

When the junction temperature drops to 150℃ (Typ.) the IC resumes operation.

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●Notes for use

1. Absolute maximum ratings
   We are careful enough for quality control about this IC. So, there is no problem under normal operation, excluding that it exceeds the absolute maximum ratings. However, this IC might be destroyed when the absolute maximum ratings, such as impressed voltages (Vcc, PVcc) or the operating temperature range(Topr), is exceeded, and whether the destruction is short circuit mode or open circuit mode cannot be specified. Please take into consideration the physical countermeasures for safety, such as fusing, if a particular mode that exceeds the absolute maximum rating is assumed.

2. Power supply line
   Due to switching and EMI noise generated by magnetic components (inductors and motors), using electrolytic and ceramic suppress filter capacitors(0.1μF) close to the IC power input terminals (Vcc and GND) is recommended. Please note: the electrolytic capacitor value decreases at lower temperatures. Current rush might flow momentarily by the order of turning on the power supply and the delay in IC with two or more power supplies. Note the capacity of the power supply coupling, width and drawing the power supply and the GND pattern wiring.Please make the power supply lines (where large current flow) wide enough to reduce the resistance of the power supply patterns, because the resistance of power supply pattern might influence the usual operation (output dynamic range etc…).

3. GND line
   The ground line is where the lowest potential and transient voltages are connected to the IC.

4. Thermal design
   Do not exceed the power dissipation (Pd) of the package specification rating under actual operation, and please design enough temperature margins.

5. Short circuit mode between terminals and wrong mounting
   Do not mount the IC in the wrong direction and be careful about the reverse-connection of the power connector. Moreover, this IC might be destroyed when the dust short the terminals between them or GND

6. Radiation
   Strong electromagnetic radiation can cause operation failures.

7. ASO(Area of Safety Operation.)
   Do not exceed the maximum ASO and the absolute maximum ratings of the output driver.

8. TSD(Thermal shut-down)
   The TSD is activated when the junction temperature (Tj) reaches 175℃(with 25℃ hysteresis), and the output terminal is switched to Hi-z. The TSD circuit aims to intercept IC from high temperature. The guarantee and protection of IC are not purpose. Therefore, please do not use this IC after TSD circuit operates, nor use it for assumption that operates the TSD circuit.

9. Inspection by the set circuit board
   The stress might hang to IC by connecting the capacitor to the terminal with low impedance. Then, please discharge electricity in each and all process. Moreover, in the inspection process, please turn off the power before mounting the IC, and turn on after mounting the IC. In addition, please take into consideration the countermeasures for electrostatic damage, such as giving the earth in assembly process, transportation or preservation.

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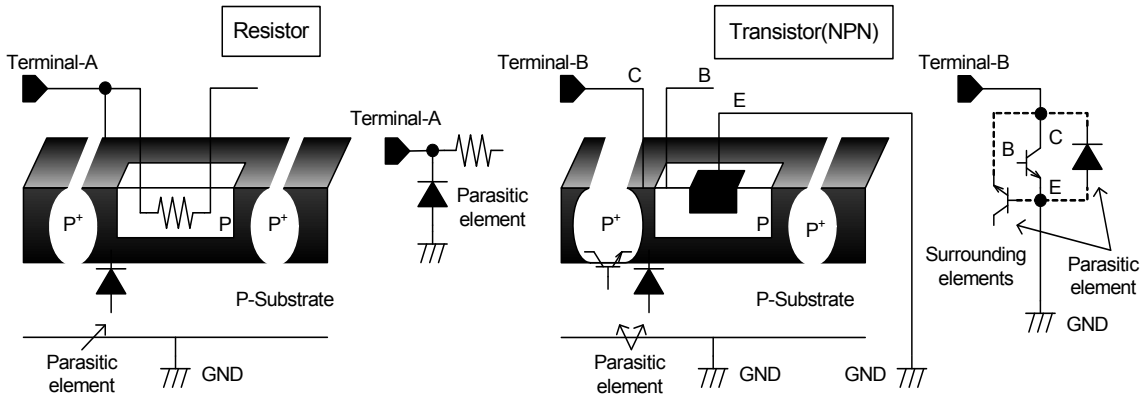
10. Earth wiring pattern
This IC is a monolithic IC, and has P^+ isolation and P substrate for the element separation. Therefore, a parasitic PN junction is firmed in this P-layer and N-layer of each element. For instance, the resistor or the transistor is connected to the terminal as shown in the figure below. When the GND voltage potential is greater than the voltage potential at Terminals A or B, the PN junction operates as a parasitic diode. In addition, the parasitic NPN transistor is formed in said parasitic diode and the N layer of surrounding elements close to said parasitic diode. These parasitic elements are formed in the IC because of the voltage relation. The parasitic element operating causes the wrong operation and destruction. Therefore, please be careful so as not to operate the parasitic elements by impressing to input terminals lower voltage than GND(P substrate). Please do not apply the voltage to the input terminal when the power-supply voltage is not impressed. Moreover, please impress each input terminal lower than the power-supply voltage or equal to the specified range in the guaranteed voltage when the power-supply voltage is impressing.



Simplified structure of IC

11. Earth wiring pattern
Use separate ground lines for control signals and high current power driver outputs. Because these high current outputs that flows to the wire impedance changes the GND voltage for control signal. Therefore, each ground terminal of IC must be connected at the one point on the set circuit board. As for GND of external parts, it is similar to the above-mentioned.

12. Reverse-rotation braking
In the case of reverse-rotation braking from high speed rotation, pay good attention to reverse electromotive force. Furthermore, fully check the voltage to be applied to the output terminal and consider the revolutions applied to the reverse-rotation brake.

13. About the capacitor between SPVM and SPGND
The capacitor between SPVM and SPGND absorbs the change in a steep voltage and the current because of the PWM drive, as a result, there is a role to suppress the disorder of the SPVM voltage. However, the effect falls by the influence of the wiring impedance etc, if the capacitor becomes far from IC. Please examine the capacitor between SPVM and SPGND to arrange it near IC.

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●Application circuit

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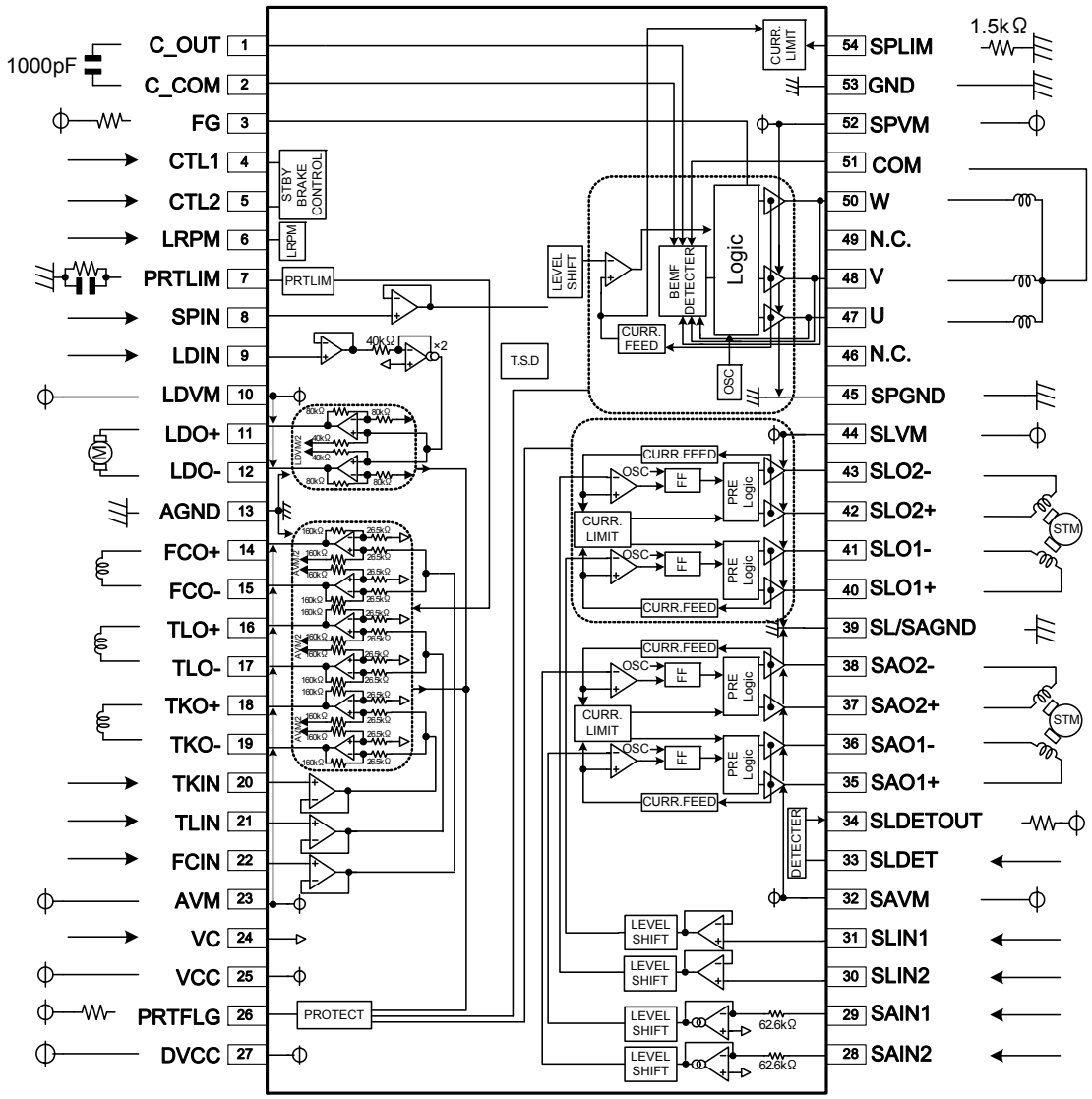

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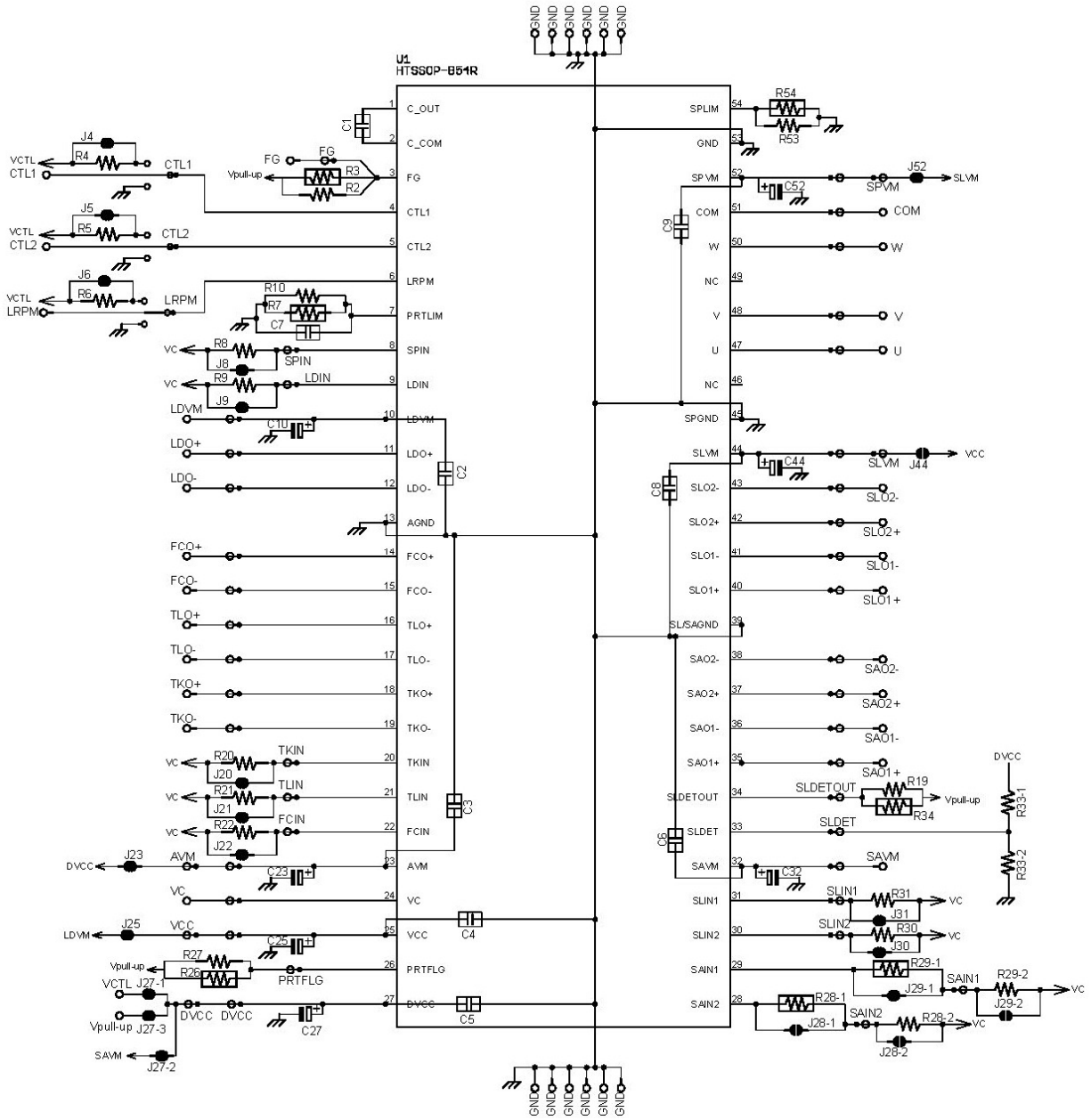
●Connecting wires of application board



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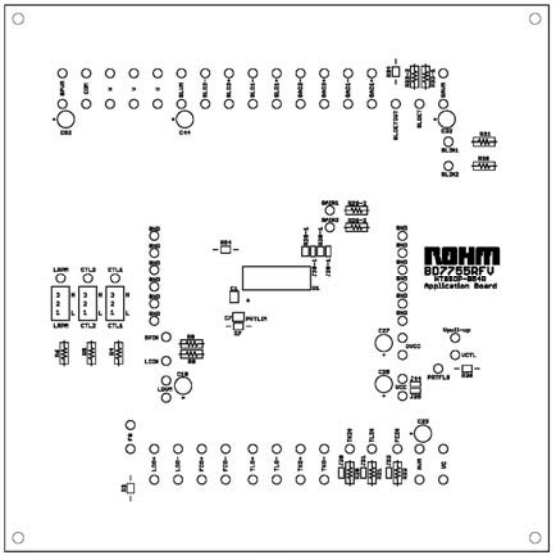
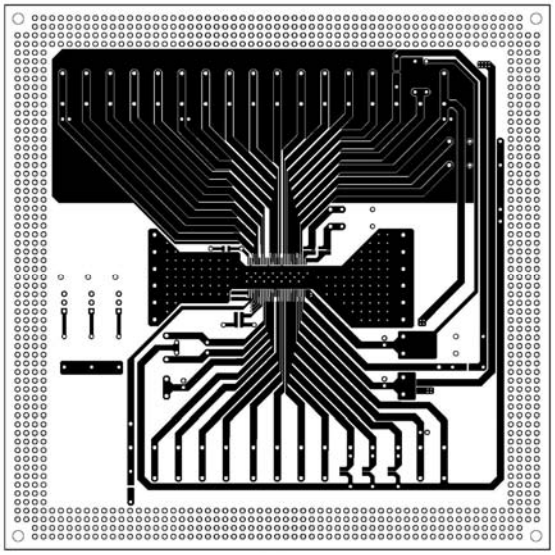
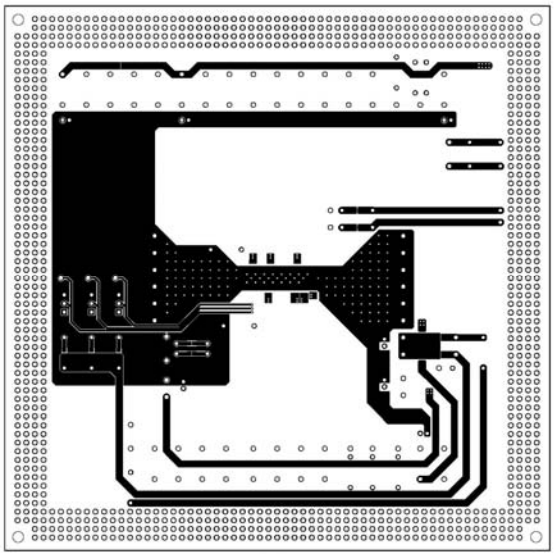
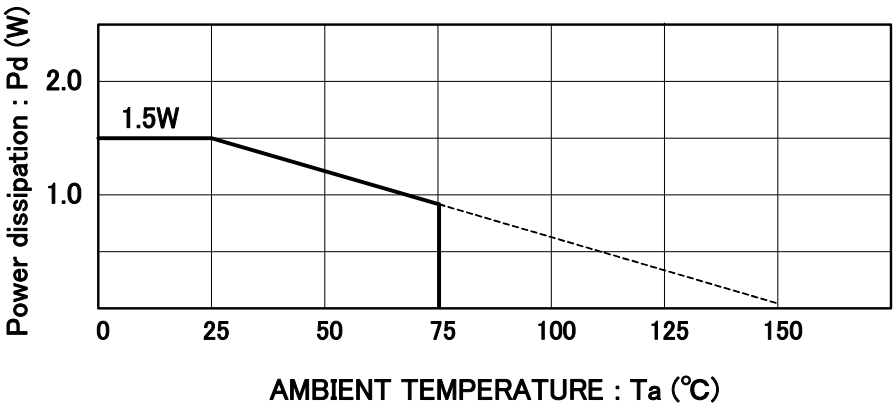
●Pattern drawing of application board







●Power dissipation reduction



*70mm × 70mm, t=1.6mm, occupied copper foil is less than 3%, glass epoxy mounting.

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●Ordering part number

B	D	7	7	5	5	R	F	V	-	E	2

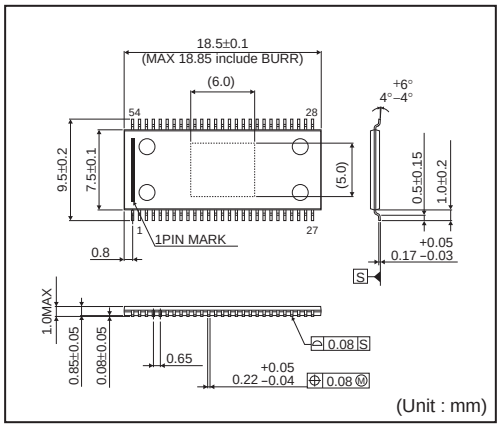
Part No.

Part No.
7755

Package
RFV: HTSSOP-B54R

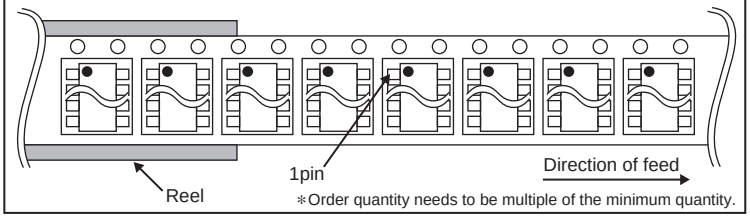
Packaging and forming specification
E2: Embossed tape and reel
(HTSSOP-B54R)

HTSSOP-B54R



<Tape and Reel information>

Tape	Embossed carrier tape (with dry pack)
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

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Notes

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